No. 158 May 2011

solplan review

the independent journal of energy conservation, building science & construction practice

Inside . . .

Airtight Drywall Approach

From The Editor . . .

We are seeing a lot of change in our lives today. We are using tools that we never even dreamed of or never knew we couldn't live without a scant 5 or 6 years ago.

Today we are also using many new materials that didn't exist a few years ago – some are re-formulations of traditional materials, others are new and helpful. Although the way we build has been refined and improved significantly in recent years, much hasn't changed. We are still largely stick framing on site.

Currently, the big change that is coming is more aggressive energy efficiency standards. New homes are more energy efficient than they've ever been, but there are still a lot of improvements that need to be made. The rationale and drive for more energy efficient standards is the need to address very real climate change issues, although it is not politically correct in today's Canada to talk about climate change. The challenge is compounded by the fact that in most of the country, current energy prices are still quite low, especially when compared to the rest of the world. This makes it challenging when reviewing costs of the standard changes.

Much debate is going on about what the new energy standards will be or should be. There is a sense that we may have reached what is achievable in today's construction environment. There is much anguish about the buildability of assemblies that may have to have more insulation than is seemingly achievable with current framing practices.

What I think we may be missing is the realization that we may need to rethink how we build. As a young graduate architect, I recall being ridiculed as an idealistic young greenhorn when I pressed for filling the 2x4 wall framing with insulation and pushing for double-glazed windows and more insulation in the ceiling and basement – or even looking at 2x6 wall framing. It took a number of years before 2x6 framing became the norm in most of Canada.

Today something similar is happening with those that are advocating adding exterior insulation in addition to that within the wall. There is a lot of teeth gnashing and whining about why we need to go to higher performance levels, that it's not buildable, etc.

There may well be implications when trying to achieve these new higher performance levels. But it also provides the opportunity to review the whole construction process. Let's start to look at ways of building other than just 2x4 or 2x6 framing. The time is right to think about alternate construction assemblies. We need to get past the analysis of immediate, short term incremental costs, which may well incorporate costs of the learning curve, and give a fair assessment of the implications to the overall impact on the house – not just capital costs but also the longer term operating costs for the homeowner.

We've adopted a whole raft of products and technologies that didn't exist a few years ago almost without questioning them. We're even abandoning some technologies that were around for only a few years – the fax machine seems to be on the way out after only a few years, supplanted by e-mail and the internet.

So why are we afraid to rethink how we build?

Richard Kadulski, Editor

solplan review
the independent journal of energy conservation, building science & construction practice

Editor-Publisher: Richard Kadulski
Illustrations: Terry Lyster
Contributors: Rob Dumont, Janet Ansell, Dennis Trotzuk, Eric Burnett, John Straube, K.J. Dick, F. Fedirchuck
ISSN: 0828-6574
Date of Issue: June 2011
SOLPLAN REVIEW is published 6 times per year by:
the drawing-room graphic services ltd.
PO Box 86627, North Vancouver, BC V7L 4L2
Tel: 604-689-1841 Fax: 604-689-1841
e-mail: solplan@shaw.ca
Street address:
#204 - 1037 West Broadway
Vancouver, BC V6H 1E3

Publications Mail Agreement No. 40013363
Postage paid in Vancouver, BC.
Return undeliverable Canadian addresses to
PO Box 86627, North Vancouver, BC V7L 4L2

SUBSCRIPTIONS: In Canada 1 year $56.00 (incl HST) (NB, NS, NF $56.50 includes HST); 2 years $100.80 (incl HST) (NB, NS, NF $101.13 includes HST). USA and other foreign payable in US $ 1 year $57.00, 2 years $103.50.

CHANGE OF ADDRESS: include a mailing label or copy all information off label for faster, accurate processing.
CONTRIBUTIONS: Unsolicited contributions and manuscripts welcome. Include self-addressed pre-stamped mailer if return requested. Publisher not responsible for loss or damage of same.
While every effort is made to provide accurate and complete information, we do not warrant or guarantee the accuracy and completeness of such information.
ADVERTISING POLICY: Publisher's discretion in the acceptance of any advertisement. No endorsement is stated or implied by the publisher.
PRINTED IN CANADA
GST Registration: R105208805

Controlling Airflow In Buildings

Control of airflow is important for building performance. Air sealing of the building enclosure serves several functions:

To *control moisture damage* as a result of air leakage. Water vapour in the air can be deposited within the envelope by condensation and cause serious health, durability, and performance problems

To *reduce energy losses*. Air leaking out of a building must be replaced with outdoor air that must be conditioned. More than 30% of space heating energy consumption in buildings is due to air leakage through the building enclosure. Convective circulation and wind washing both reduce the effectiveness of fibrous thermal insulation and thus increase energy transfer across the envelope.

To *provide comfort and health*. Cold drafts and the excessively dry wintertime air that results from air leakage directly affects human comfort. Wind-cooled portions of the interior of the enclosure allow condensation to take place that supports biological growth which in turn affects indoor air quality. Airborne sound transmission control also requires good airflow control, and odours and gases from outside and adjoining buildings can annoy or cause health problems.

Understanding Air Leakage

Air leakage across the building enclosure requires a pressure difference between the inside and outside of the building, and a hole through which air can flow.

There are three main factors affecting the pressure difference that can act individually or in combination:

Wind: on the windward side of the house, there is a positive pressure pushing outside air in, and on the leeward side a negative pressure sucking air out of the house

Stack effect: warm air is lighter and more buoyant than cold air. When air is heated, warm air rises to the upper part of the building and when it finds openings (such as unsealed penetrations in an upper floor ceiling) it will leak through. Replacement (colder) exterior air is drawn through openings in the lower part of the house. The stack pressures are not as large as those caused by wind, but they are constant during the heating season, and greatest in the coldest weather, so they have a big impact on the overall volume of air leakage.

Mechanical: exhaust through fans, chimneys and flues draws air outside so replacement air will be drawn in through other openings in the enclosure.

Purpose Of The Air Barrier

Air barriers limit the rate of air leakage between the inside and the outside the building. Any material that will resist air movement can be used as part of the air barrier system – they can be sheet materials, some insulation materials, structural elements, sealants or gaskets. Building an effective air barrier, which must be continuous, requires careful sealing of critical junctions.

There are four common approaches for constructing the air barrier:

Sealed polyethylene. This has become very common and is familiar to most Canadian builders today. Polyethylene installed on the interior and is caulked and sealed. The polyethylene serves two functions – not just as the air barrier but also as the vapour barrier.

Airtight drywall approach (ADA). This approach relies on the interior drywall as the air barrier. It requires careful installation of gaskets and caulking to provide continuity of the air barrier between structural elements.

Exterior insulation. Rigid insulation panels installed on the exterior and sealed at the joints can be an effective air barrier.

House wrap. Air impermeable house wraps, installed with care and sealed at all joints, can also be effective air barriers.

The Building Code requires an air barrier in all enclosures, but does not require or prescribe any specific air barrier approach. Any approach is acceptable as long as the performance objectives are met.

Air Barriers vs. Vapour Barriers

The separate functions of air barrier systems, vapour barriers and weather barriers are often misunderstood. Vapour barriers are materials that resist the diffusion of water vapour, but they do not need to be structural. The fact that many vapour barriers also retard or eliminate airflow

causes much confusion. A lot of older literature (and even some current documents) confuse or combine the function of the air barrier and vapour barrier. The difference between the two is still one of the most common building science questions.

The function of the vapour barrier is simply to control water vapour diffusion to reduce the likelihood of condensation within the construction assembly. It only has one performance requirement – it must have a specified vapour permeance and be installed to cover most of the area of the enclosure.

Air barriers must be continuous, have structural integrity or be structurally supported, be durable and air impermeable.

Measuring Performance

At present there are no defined airtightness levels for a house that must be met, although draft BC Building Code changes to be published next year have a mandatory performance level, to be confirmed by blower door testing. However, air barrier materials are defined as materials which allow less than $0.02\ l/s/m^2$ @75 Pa. Although this is an easy property to measure it is not as important as might be thought, because it is the ability to achieve continuity across the assembly that is more important. The air permeance of joints, cracks, and penetrations outweighs the air permeance of the solid materials that make up most of the area of the air barrier.

Available evidence indicates that the average Canadian built today is much tighter than ever before – the average new house measures 3.1 air changes at 50 Pascals, although there are geographic variations. Manitoba new houses are the tightest with new homes approaching the R-2000 standard of 1.5 air changes while BC has the loosest at an average of just over 4 air changes.

Polyethylene is commonly used to air seal buildings. The polyethylene is caulked and sealed to provide not only the vapour barrier, but also the air barrier. It has become the most familiar air sealing approach for most builders and building officials. It is seemingly easy to inspect (even though that doesn't ensure good air-sealing) and it provides the vapour barrier at the same time. In practice, it can be difficult to achieve continuity, especially as it is pierced by services and other penetrations at many locations. It can fail structurally when exposed to wind gusts and can fail through fatigue if it flaps because of varying wind gusts.

The vapour permeance of polyethylene is around 6 $ng/Pa \cdot s \cdot m^2$ but the code defines any material with a permeance of less than 60 $ng/Pa \cdot s \cdot m^2$ as a vapour barrier. Experience and evidence is now showing that an airtight but slightly more vapour permeable building enclosure is important for long-term building durability.

Increased airtightness must be matched by an appropriate ventilation system to dilute pollutants, provide fresh air, and control cold weather humidity levels. Good airflow control through and within the building enclosure will bring many benefits: reduced moisture damage, energy savings, and increased health and comfort.

Air barrier systems should be clearly shown and labelled on all drawings, with continuity demonstrated at all penetrations, transitions and intersections. Enclosure assemblies should be vertically and horizontally compartmentalized, and may require secondary planes of airtightness (such as those provided by housewraps and sealed rigid sheathing). In practice, there may be more than one air barrier and they can add to the overall performance. Multiple air barriers will also provide a measure of back-up if the primary air barrier is not installed properly, and may improve the overall airtightness.

The guiding principle is that the air barrier must be systematically sealed to form a continuous barrier to air movement throughout the exterior enclosure. ☼

Basic Requirements of Air Barrier Systems

Typically, several different materials, joints and assemblies are combined to provide an uninterrupted plane of primary airflow control. Regardless of how air control is achieved, the following five requirements must be met by the air barrier system:

1. Continuity. This is the most important and most difficult requirement. Enclosures are three-dimensional systems. Air barrier system continuity must be ensured through doors, windows, penetrations, around corners, at floor lines, soffits, etc.

2. Strength. If the air barrier system is much less air permeable than the remainder of the enclosure assembly, then it must also be designed to transfer the full design wind load (e.g., the 1-in-30 year gust) to the structural system. Fastenings can often be critical, especially for flexible non-adhered membrane systems.

3. Durability. The air barrier system must continue to perform for its service life. Thus, the ease of repair and replacement, the imposed stresses and material resistance to movement, fatigue, temperature, etc. are all considerations.

4. Stiffness. The air barrier system must be stiff enough to reduce or eliminate deflections to control air movement into the enclosure by wind gusts. It must also be stiff enough so that deformations do not change the air permeance and/or distribute loads through unintentional load paths.

5. Impermeability. The air barrier system must be impermeable to air. Typical recommended air permeability values are less than about $1.3 \times 10^{-6}\ m^3/m^2/Pa$.

From ***Building Science for Building Enclosures****, by John Straube and Eric Burnett, Building Science Press Inc*

Airtight Drywall Approach

ADA Materials are standard, commonly available materials.

Sheet panel materials: drywall

Gaskets: closed cell low-density self-adhesive foam strips to seal drywall to framing

Fasteners: Self-adhesive gaskets should be stapled into place to ensure the installation of the drywall doesn't dislodge them.

Caulking: One-part polyurethane or other appropriate caulking can be used to seal framing to subfloor and around penetrations.

Foam sealants: Low expansion spray foam can be used to seal window and doorframes and other larger openings. Care must be used to ensure that the foam doesn't put undue stress on the assembly, nor should it be overfilled. However, caulking over backer-rod may be the preferrable way to airseal windows.

Airtight Drywall Approach – ADA

The airtight drywall approach (ADA) offers one alternative way to achieve a "breathable" building enclosure. It relies on the continuity of air barrier provided by the interior drywall, with caulking and gasketing selectively located to provide continuity of the air barrier.

The building code is quite explicit in defining air barriers as a separate element from the vapour barrier. Unfortunately, we still hear of building officials creating difficulties for those who wish to do ADA rather than the polyethylene approach, perhaps because of misunderstanding about details or lack of familiarity.

By careful attention to caulking and sealing, relying in large part on drywall to provide a structural air barrier, an airtight, but slightly more permeable assembly can be achieved. The vapour barrier is a low permeance water based paint applied to the drywall. A number of such paints are on the market – these are all drywall primers, so are applied before final paint coats are applied and do not have any impact on the interior finishing.

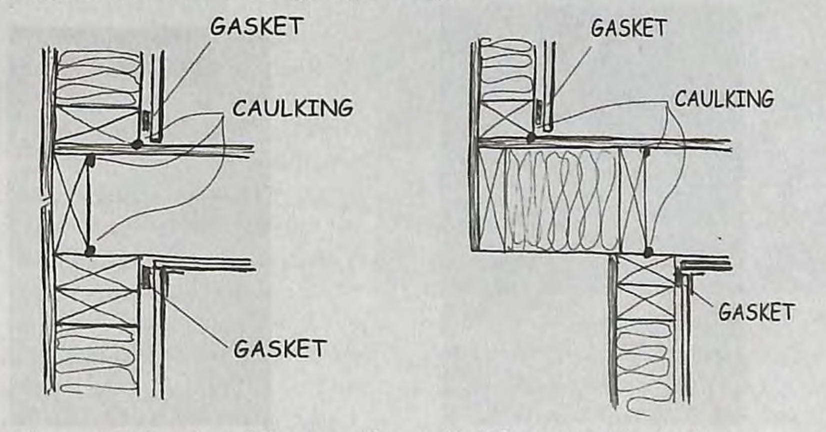
Unlike polyethylene, which is hidden behind finishes, ADA offers a structural air barrier that will always be maintained – since people will generally plug any holes in the wall. Those extra holes made by trades in the finishing stages of construction, that punch through the poly, will be sealed when they are made in the drywall.

The advantage of ADA is that the air barrier uses standard materials, can allow for conventional scheduling of trades, provides a rigid air barrier that can withstand wind pressures, will survive construction abuse, has a long life and can easily be repaired over the life of the building. In addition it has a slightly higher permeability than polyethylene so that it will permit minor amounts of vapour diffusion without creating a build-up of moisture, but still complies with code requirements.

ADA Construction Details

The sill plate, joist headers and subfloor material must be constructed airtight by sealing all junctions between structural components. Continuity of the air barrier can be maintained at the header by using caulking around the framing, and gaskets between the sill plate and the drywall. Spray foam insulation in the rim joist area is also an effective air barrier material.

The joint between windows, doors and wall assemblies can be made airtight by sealing all



Floor-wall detail, and floor cantilever. Airtightness continuity is achieved through the drywall, framing and use of caulking and gaskets at appropriate locations.

junctions between the framing and the window, door, or skylight frame by using caulking applied over a backer rod installed in the gap between the window and framing, or a low-expansion foam.

Interior walls meeting exterior walls or ceilings are made airtight by applying gaskets to framing, and sealing all penetrations through the framing, to ensure that there is an airtight plane between the drywall to framing.

Overhangs and floors over unheated spaces (this would include floors over a garage) or over the exterior must be constructed airtight by caulking and sealing the floor framing with a combination of sealants and gaskets. This can be complemented by wrapping the underside with an air-impermeable housewrap membrane.

Electrical outlets and recessed light fixtures that penetrate the air barrier must be constructed airtight by using airtight electrical housings and sealing the wiring penetrations, or by using an airtight housing around the outlet. A number of airtight plastic boxes, some with gasketed flanges, are now readily available.

So-called airtight pot lights seldom are airtight, so require additional care and attention. The most effective still is building an airtight housing over the pot light. ☼

Consequences of Poor Air Tightness: Why Air Sealing is Important

We received a number of startling photos taken by an insulation contractor who was asked to quote on a house undergoing major renovations after a fire incident.

The house is a typical Vancouver-area home built in compliance with the building code in effect in the early 1990s. It is a two-storey slab-on-grade house. The house had vinyl siding on 2x4 framing, fibreglass batt insulation, and an asphalt shingle roof.

The second floor contains the main living area – including kitchen, living, dining areas and bedrooms. The ground floor was originally built as unfinished "basement" space, but was finished for a secondary suite. The lifestyle and number of occupants may have meant that indoor relative humidity might have been slightly higher than normally found in single-family homes.

The neutral pressure plane of the house probably was somewhere near the floor level of the upper floor, so that the air leakage from the upper portion of the house was exfiltration – air moving outward. The lower floor would have been at a lower pressure than the upper floor, so air leakage would have been inward, drawing outside air in.

Fig 1. Air leakage through a ceiling electrical outlet is evident behind the outlet even though it has a poly boot behind it and was caulked for the polyethylene air/vapour barrier. Failure to caulk the wiring penetrations through the poly boot renders it useless as an air barrier.

The photos show the importance of having a good air barrier and what happens where there are problems with the air barrier. It also points out the importance of attention to mechanical system design and installation practices.

Serious deterioration of the structure is visible immediately behind locations that often represent air sealing challenges.

Fig 2. Air leakage through a wall electrical outlet is evident behind the outlet even though it has a poly boot behind it and was caulked for the polyethylene air/vapour barrier. Failure to caulk the wiring penetrations through the poly boot renders it useless as an air barrier.

Fig 3. Hood fan duct through the ceiling. The duct joints are not air sealed, allowing a significant amount of air leakage into the attic, where moist air condenses on the underside of the roof sheathing.

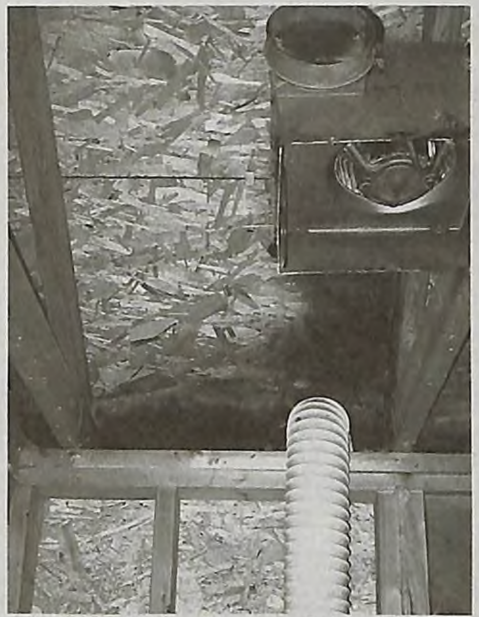


Fig 4. Bathroom fan vented through a flexible duct through the soffit. Soffit vents adjoining the grille allow moisture into the attic where it condenses on the underside of the roof sheathing.

Fig 5. Electrical cable for the kitchen hood fan was not sealed and led to deterioration of the wall sheathing.

Radiant Barrier Insulation Products: They Don't Deliver What They Claim

Foil-faced reflective insulation products are aggressively marketed as a miracle insulation product. Outlandish claims have been made for these insulation products. Often references made to tests and other research reports as a support to the claims are out of context. Unfortunately, few follow up those references to see what they state – what was the objective of the research or study, what where the results, and where are they even relevant.

One manufacturer states on their web site "we have received confirmation from the International Code Council Evaluation Service (ICC-ES) that P2000 Insulation complies with the provisions of the 2006 International Building Code (IBC), International Energy Confirmation Code (IECC) and the International Residential Code (IRC)."

What they don't state is which climate zones this approval would apply to. When referenced reports are reviewed, the fine print indicates that one specific wall assembly with 1" thick foil-faced EPS insulation analyzed is rated at an overall R-10. No areas in Canada would accept R-10 for exterior wall insulation.

Some puffery and exaggeration can be expected in sales presentations and at trade shows, but unrealistic claims are made forcefully enough than many assume there must be some credible backing to support such a claim and accept the claims. Often, the claims are only supported by anecdotal testimonials that do not present a fair performance assessment.

We've written about these products a number of times over the past few years. Our analysis and commentary was always based on well-understood scientific principles and standard engineering principles.

Although all standard test procedures used for insulation materials may not always be ideal to all product types, and may have their shortcomings, they are the accepted tests for material testing. Imperfect though they may be they do provide a basis of comparison.

Exaggerated claims for foil-faced products are still being made, quoting reputable testing agencies, even though the test agencies are on record that they have not made such claims and have expressed concerns that some of their test results have been misquoted.

Some product manufacturers are careful not to state in writing the exact R-value per inch, but they imply that their product outperforms 6" of batt insulation. One supplier boldly states "the

thermal performance of the 1" P2000 wall meets or exceeds the performance of the R-19 fiberglass wall system".

In March 2008, one manufacturer indicated that a real world test should be conducted to evaluate the actual performance of competing insulation systems, rather than just relying on academic and laboratory tests.

He suggested that "an example of a "real world test" would be two identical buildings constructed to National Building Code Standards. One building would be insulated with R-20 fiberglass insulation, the other with one-inch P2000 Insulation. Both buildings would be exactly the same size in the same real world environment. They would have identical heating and cooling systems and the energy consumption of both buildings would be monitored for one year. At the end of the year, the building that uses the least amount of energy will be considered the most energy efficient, no matter what the labelled R-value states. Upon completion of the testing, both buildings would be dismantled and inspected for mildew, rot and structural deterioration. The results would be made public and would be presented to all energy code enforcers in both Canada and the USA.

"According to most so-called experts there is no way P2000 can perform as advertised, especially in predominantly cold climates. Consequently, the testing should be conducted in a cold climate. Lastly, we would require the test be conducted by an accepted independent third party that could not be bribed, bought or influenced. I am sure you or any other expert would have to agree this is the best and most accurate way to compare two insulation systems."

Since then, just such a test has been done at the University of Manitoba. The objective of the research was to obtain baseline data on the relative performance of a foil-backed EPS product compared to friction-fit fibreglass batt insulation for wood-frame residential buildings. The preliminary test results were presented in Winnipeg at the 13th Canadian Conference on Building Science and Technology.

Two identical test buildings, each 12 feet wide, 20 feet long, were built side by side on the university campus. Both were conventional wood frame buildings with 2x6 SPF studs at 24" on centre with vinyl siding. The roof system is wood trusses at 24" on centre with sheathing and asphalt shingles. The floor system was 2x8 SPF dimensional lumber at 16" on centre. One structure was insulated using R-20 (RSI 3.51) friction-fit fiberglass batt insulation, in keeping with typical residential building practice, and two layers of fibreglass batt insulation in the ceiling and floor.

The second structure was framed the same way but was insulated using foil-backed EPS in accordance with the manufacturers instruction for installing the product. The foil-backed EPS was placed directly onto the surface of the exterior sheathing behind the vinyl siding. There was no insulation within the stud cavity. Two layers of foil-backed insulation were installed in the ceiling and floor. The interior of both buildings was finished with ½" paper-backed gypsum wallboard that was not taped.

Both were airtightness tested. The small size of the unit created a challenge for the testers, but they determined that the units were very airtight, and the difference in the airtightness between the two was negligible.

The preliminary results indicated that over the test period the foil-backed building consumed about twice the amount of energy as the fibreglass insulated building to maintain identical set-point temperature. Electrical power consumption totalled 2,233kWh in the foil-backed EPS-insulated building, and 1,168kWh in the fibreglass-insulated building.

Based on the preliminary results, a one-inch thick foil faced insulation board simply cannot be considered as a substitute to R20 insulation.

The testing programme will continue over the coming year. After a review of the data with the industry partner a reconfiguration of the insulation application to the building may be done to investigate the radiant properties of the foil backing using other configurations.

Foil-faced insulation products do have their place, but exaggerated claims should be avoided. It is the EPS board that provides much of the insulating value although the EPS itself only has an R-value of 4 per inch or less. The foil face may increase the thermal performance, depending on its location and the environmental conditions. However, the sealing (with a tape) of all joints in the insulation helps make the building more airtight, reducing air leakage..

By placing the insulating board over the framing it also significantly improves the building performance by reducing thermal bridging through the framing elements to improve the effective value of the whole assembly. ✪

Comparison of Energy Consumption for a Wood Frame Building Using Batt Insulation and a Foil-Backed EPS Foam Board
by Dick, K.J. Ph.D., P.Eng. and, Fedirchuk, K. BSc, EIT. Paper presented at 13th Canadian Conference on Building Science and Technology, Winnipeg, Manitoba, May 10-13, 2011

Building Code News

The National Energy Code for Buildings that applies to larger buildings built under Part 3 of the code has been approved by the Canadian Commission for Building and Fire Codes (CCBFC) and will be released later this year. The goal was to make buildings 25% more energy efficient than the minimum requirements of the previous (1997) edition of the NECB.

Unlike the larger building sector, the Model National Energy Code for Houses which was published in 1997, was never used and is behind current practices. The energy requirements for houses and small buildings will be incorporated into the National Building Code, rather than being kept as a separate document.

Energy efficiency requirements for houses and small buildings (those built under Part 9 of the code) are being finalized now, and will be put out for public review later this year. The energy efficiency criteria will not be setting out an energy performance target or rating for houses at this time. However, they are being developed so that the prescriptive standards will achieve an energy performance level equivalent to an EnerGuide rating of 80 for the average house.

Energy Use and Greenhouse Gas Emission Performance in Canadian Homes: 2008 Update

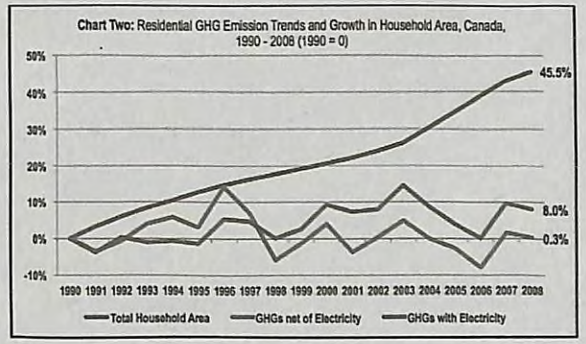
A just released report by CHBA looks at Canada's housing stock, including the rate at which older homes are removed from the housing stock to assess the overall environmental performance of the housing sector. Canada's housing has achieved considerable improvement in both energy efficiency and greenhouse gas emissions in the past 20 years. The actual level of improvement fluctuates from year to year, in response to variability in annual weather conditions, because 60% of all residential energy use is tied to space heating.

When looking at the trend data for the period from 1990 to 2008 it is noteworthy that efficiency improvements have occurred in both existing and new construction. Between 1990 and 2008, 4.4 million new homes were built resulting in a 33% net increase in the number of homes in Canada, and a 45.5% increase in total floor area. Over the same period, total residential energy use grew by only 14.3%.

Canadian Home Builders' Association

Technical Committee Research News

While new homes are considerably more energy efficient than older homes, the impact of retrofitting and equipment upgrades in the older stock has been considerable. Greenhouse gas emissions from Canadian homes during the period rose by only 0.3%, in sharp contrast to increases in many other sectors of the economy. The very positive greenhouse gas emission performance of the housing sector is made even clearer when compared to that achieved by the commercial/institutional building sector, which grew more slowly than housing, but saw its greenhouse gas emissions increase by over 36%.



There are many factors at play in the positive environmental performance of the residential sector. New homes are more energy efficient than older homes. Most household appliances and fuel-fired residential heating equipment have seen significant increases in efficiency. Homeowners continue to invest in improving the energy efficiency of existing homes. And a significant number of older, less energy efficient homes have been removed from the housing stock.

The level of residential wood/biomass use for space heating varies considerably by region, from a low of 0.3% in Alberta to a high of 26.8% in New Brunswick. Given that space heating represents almost two-thirds of all residential energy use, the use of wood fuels has significant impacts in terms of residential GHG emissions in some provinces.

Under international protocols, biomass-based energy is zero-rated in terms of GHG emissions, as it represents both a GHG source and sink. While Canada is a highly urbanized nation, biomass remains a significant, and growing, source of residential space heating energy, contributing about 11% of the total space heating load on a national basis.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
Canadian Home Builders' Association, Suite 500, 150 Laurier Ave. West, Ottawa, Ont. K1P 5J4
Tel: (613) 230-3060
Fax: (613) 232-8214
e-mail: chba@chba.ca
www.chba.ca

Electricity Use In the Home

Electrical use in homes accounts for a significant amount of energy. The variety of consumer electronics, lighting options, and other household appliances in use today imposes significant electrical loads. Some of these are known as phantom loads – power draws from appliances that are seemingly switched off, and those in stand-by mode. Unlike commercial and institutional environments where it can be accounted for and managed with a degree of certainty, there is little concrete data on household electrical use.

Natural Resources Canada has had a research project doing electrical use audits in some 500 homes in BC, Nova Scotia and New Brunswick. Results should be available shortly and will for the first time show how Canadians use electricity.

High Performance Houses: the EcoPlusHome

The interest in very high performance, net-zero houses is growing. Builders of the CMHC EQuilibrium houses are finding customers for similar houses. A few builders are now building similar homes to meet a small emerging market demand.

In New Brunswick a private net-zero construction consortium has set up shop to build Net-Zero energy houses. In 2008 they planned and built their first house as a test house – the EcoPlusHome in Bathurst, New Brunswick.

Their goal was to create a smart home environment that would not rely on fossil fuels for electricity or heat. With winter temperatures of -35°C and summer temperatures of 35°C, the location offered a climate with good extremes.

The Test House, built by Maple Leaf Homes, was designed and built as a complete system: an airtight modular home with the right orientation on the right site, that incorporated the best, advanced energy-efficiency systems and materials. The 2,200 sq.ft. two-level house used standard 2x6 framing with R-25 insulation overall, insulated concrete form foundation, and R-50 ceiling insulation. It has three integrated energy systems: geothermal for heating and cooling, solar thermal for domestic hot water and photovoltaic for electricity generation. All equipment used is by Bosch.

A six-member family spent 12 months (2009-2010) in the house during which time it generated and conserved the energy they needed to live comfortably through the area's seasonal temperature extremes. In 2010, Efficiency New Brunswick rated the Bathurst Test House as meeting an EnerGuide rating of 96, making it the most efficient house rated in New Brunswick.

Since April 2010 the Bathurst house generated about 30% more electricity than expected. The photovoltaic system provided by Bosch produced more than 6,200 kW/hrs with a daily average of 48.8 kW/hrs. The peak generation per day was over 80 kW/hrs and the lowest generated electricity was still more than 7 kW/hrs per day. If the test house can maintain the same generation for a period of one year the house would generate 17,800kW/hrs. (The average electrical energy consumption of a Canadian household is around 11,000kW/hrs per year).

The Scotiabank EcoLiving Innovators Award (which recognizes innovators and students for excellence in the development of home energy efficiency initiatives) was awarded to the EcoPlusHome in June 2011.

Letters to the Editor

Re Solar Domestic Hot Water Systems

I am writing to congratulate you on a very well written article on domestic solar hot water systems in the last issue (Solplan Review No, 157, March 2011).

A lot of the issues you raised are familiar to me, as I have been involved in promoting solar energy in local governments for several years. I used to be the director of Planning and Sustainability in Dawson Creek and I am now in Sechelt. The building code change to allow "solar-readiness" was initiated in Dawson Creek, under my direction, and one can see very reliable solar hot water systems installed in the Peace Country in nearly all municipal buildings, a testament to the leadership of smaller communities in BC.

Much like you found, I too found very disturbing the pushback I got from building/plumbing inspectors all over the province during my numerous presentations at conferences and workshops. The lack of provincial leadership in tackling some of these issues, such as double wall heat exchangers and backflow preventer valves earlier only compounded the problem. What is happening to the solar industry in BC speaks volumes of the need to take a serious look at the "jurisdiction" over inspections and code interpretations.

Unchecked, we have allowed the creation of an inspection regime that does not seem to answer to anyone and the serious patchwork of requirements gives the whole regulatory system a bad name.

The Province needs to issue very clear direction of what systems are accepted, how they should be installed and make it the same all over the province and not allow rogue plumbing inspectors to create havoc for industries and economies such as solar, as has been allowed to happen in BC, so far.

I really enjoy really your publication, after which a healthy discussion with the building department ensues.

Emanuel Machado
Manager of Sustainability & Special Projects
Sechelt, BC

Re: Editorial, (Solplan Review No, 157, March 2011).

Your March 2011 issue was especially noteworthy from my perspective. It is no secret that I champion leading edge housing innovation and the removal of regulatory barriers that stifle the progress of advanced building concepts. For some time I have been thumping this drum, at times without awareness that my message is heard or appreciated. It is disconcerting that you are encountering regulatory barriers on the West Coast similar to those that I experience on the East Coast.

At the risk of over-generalizing, it would appear that innovation is under regulatory assault in epidemic proportions from coast to coast to coast – a serious state of affairs for the well-being of our country. Any other aliment would be front-page news, so I'm left to conclude that the leading edge, the 'lifeblood of the new world' as you so aptly put it, are the 'canaries in the mine'.

Your articles are a two-edge sword; they will cause the faint of heart to think twice about trying new things in a country that up until recently seemed to pride itself on home-grown creativity and Canadian innovation, but most importantly they will encourage the innovators to lean a little stronger into the wind. Running against the wind is not particularly easy but it sure creates a great sense of satisfaction.

I am encouraged to hear the thump of a distant drum... on a distant shore.

I am a big fan of Solplan Review. Keep up the good work. Your journal is second to none.

Steven Crowell
Kentville, NS

Re: Code Interpretations: You Can Fight City Hall (Solplan Review No. 157, March 2011)

As usual Solplan Review has timely and enlightening articles. Your article hits home.

We are envelope renovators in Victoria doing mostly residential projects. We are probably the only ones using open mesh rain screen products to define the capillary breaks in this area. We have run into inspectors who have fought us on this very issue. Knowledge has served us well in these disputes, however, on occasion because of our insistence, we have been given a difficult time through the whole renovation process.

Many inspectors tend to be comfortable with the status quo and some don't like to be told and proven they are wrong even when the utmost of diplomacy is used. This, as many builders know, can happen on any building issue and has led us to treating these people like deities for fear of getting a difficult time.

Bart Blainey
Victoria, BC

Energy Answers

Rob Dumont

I have heard about "Tunnelling through the cost barrier" from Amory Lovins to reduce the incremental cost of energy efficiency projects. Has anyone done that with residential housing?

Yes.

I attended the Affordable Comfort conference in San Francisco in early April. At the conference Robb Aldrich of Steven Winters Associates in the U.S. talked of several homes in the eastern US that used this technique.

The tunnelling technique used was quite straightforward: The insulation levels in the houses were raised significantly to about R-40 in the walls and R-50 in the ceilings, and about R-20 in the floors. Low-e and argon-filled windows with low conductivity spacer bars were used, along with a tight envelope and mechanical ventilation. The houses were oriented for passive solar gain. A photo of one of the projects is shown in Figure 1.

Figure 1. Low Energy House in Colrain, Massachusetts using a simple heating system. Outdoor temperatures have reached as low as -21˚C. (Photo credit Robb Aldrich, Steven Winter Associates)

With these much higher levels of energy efficiency, the peak space-heating load of the houses was radically reduced to the 13,000 BTU/hour range (about 3.8 kW).

A picture of the single room heater that was used in the Colrain House is shown in Figure 2.

Figure 2. Very simple Monitor Products GF1800 point source natural gas space heater with sealed combustion and output of 16,000 BTU/hour and an Annual Fuel Utilization Efficiency of 83%. Note the thickness of the R-40 walls.

With those low heat loss numbers, very simple point source heating systems were able to be used in the houses.

Some houses used the space heater, and some used higher efficiency mini-split heat pumps to meet the loads. No duct systems were used to distribute the heat, and yet all the rooms in the house were comfortable. Natural convection and a modest ventilation system using Panasonic Whisperheat fans were used to distribute the heat.

By eliminating a furnace and all the accompanying ductwork and substituting a point source heater, significant dollars ($4,000) were saved. The money saved on the heating system was invested in the energy conservation features for the house (about $7,000).

Thus the net incremental cost for these superinsulated houses was only about $3,000 excluding the active solar photovoltaic and solar thermal panels.

What are approximate typical installed costs for point source heating in a modest home (1,100 sq.ft)?

Two 2,000-watt electric baseboard heaters: $400
Natural gas space heater: $2,500
Natural gas fireplace: $3,000
Oil-fired space heater: $2,500
Mini-split heat pump: $3,500

By contrast, a properly designed and fully ducted natural gas furnace would cost about $7,000 to $10,000. A ground source heat pump would likely cost about $20,000 to $30,000

About a decade ago my siblings and my wife, daughter and I built a new cabin in the Rockies. (Figure 3) We superinsulated the house, sealed it well and reduced the heat load dramatically.

Although the cabin has about 1,900 square feet of floor area, we were able to use a very simple heating system to keep it warm. We used electric baseboard heaters. In many parts of Canada, electric heating is not a great idea because of the fossil fuels used to produce it. However, in BC almost all electricity generation is from hydroelectricity. The money we saved by not using a gas furnace was put into the extra insulation and air sealing for the house.

Figure 3. Low Energy House in the Canadian Rockies that uses a high integrity envelope (R-36 walls, R-40 attic, R-15 slab, tight air barrier) along with a simple heating system—electric baseboards

A further side benefit of the electric heaters in the cabin has been the absence of any maintenance on the heaters over the last decade. (And the heaters we used were recycled from other buildings.) For simplicity nothing can surpass an electric baseboard heater as there are no moving parts to wear out.

Another example of using point source space heating was provided by a retrofit project of a multi-family building in Regina done by Harold Orr of superinsulated houses fame. The 1950s vintage 4-plex was radically retrofit, with about R-40 insulation added to the walls and R-50 to the roof. In addition a new air vapour barrier was added.

A photo of the 4-plex after the major retrofit is shown in Figure 4.

The building was well sealed and a heat recovery ventilator used to provide ventilation. For each of the 4 suites in the building, a single natural gas fireplace was installed for heating. The back bedrooms in each suite were each given a 500-watt electric resistance heater. However, there is usually no need for electric resistance heaters because natural convection will provide the space heating. In addition, as the landlord supplies the natural gas for the building and the tenants pay for the electricity used, the tenants rarely use the 500-watt heaters.

Figure 4. Superinsulated and sealed 4-Plex in Regina post-retrofit. Each unit is heated by a single natural gas fireplace

A photo of the building after the retrofit is shown in Figure 4. If you look carefully, you can see the vents for the four fireplaces on the wall facing the street.

The fireplaces cost $2,500 each installed. This was significantly cheaper than installing a separate gas furnace for each unit.

People don't buy heating equipment for the sake of having it. They want thermal comfort.

Tunnelling through the cost barrier has been shown in these houses. Better building envelopes have allowed the use of simpler and smaller heating systems. ☼

Reno demo update

Construction on the renovation revealed a problem that is not uncommon in single-family houses.

A side door to the ground floor suite had a flat roof porch on the side of the house that gets the most severe wetting during rainstorms. It was discovered that the finishing details were poorly executed at the connection detail between the wall and the porch roof that allowed water to get behind the siding.

The addition was built fifteen years ago during an earlier renovation. The walls on the addition were structurally insulated panels (OSB skins with polyurethane foam core). The exterior siding was installed over a ¾" rainscreen.

The three-dimensional roof-wall intersection detail was not properly flashed, so that rainwater from the roof ran down the siding and behind the siding against the stressed skin panel. When the siding was pulled off to tie in new siding, the deterioration was discovered.

Although the damage was serious, the extent was not yet severe enough to have compromised the structure. We were able to remove a little bit of the most damaged face to allow the OSB to dry and then reinstall the siding.

This points out one of the benefits of rainscreens – had we not had that capillary break behind the siding, the damage would have been much more severe, possibly leading to severe structural damage well before now. In our case the rainscreen reduced the wetting of the structure and lowered the risk of moisture damage. ☼

Water spilling from roof against the siding, and behind into the rain screen added moisture that led to this deterioration. Periodic drying through the rain screen venting slowed extent of deterioration.

New Building Science Training and Research Program

The British Columbia Institute of Technology (BCIT) is introducing Western Canada's first masters degrees in Building Science: a Master of Engineering and a Master of Applied Science in Building Science. Developed through the Building Science Centre of Excellence (BSCE) in the BCIT School of Construction and the Environment, these programs will begin in September 2011 and will meet industry demands and help students develop the practical skills needed to build durable, healthy, and sustainable buildings.

Professionals in building science have traditionally met construction industry qualification through on-the-job-training and a combination of educational programs from related disciplines. These new programs are intended to create a pool of highly qualified and experienced professionals.

The masters degrees in Building Science will provide students with integrated science-based knowledge and the skills necessary to meet the challenges of industry. There will be two options: a one-year, full-time Master of Engineering degree combining an intensive set of courses with an applied research project; and a full-time Master of Applied Science in Building Science requiring a smaller set of courses and a more in-depth fundamental research project over two-years. Both programs can also be taken on a part-time basis.

Graduates will be building science professionals capable of systematically and creatively applying their knowledge and advancing their profession. Because building technology is rapidly evolving to respond to economic growth and social and environmental concerns, BCIT's applied masters training and research will help graduates meet the demands of this industry.

In addition, the provincial government is providing $50,000 to support research to be undertaken as part of the masters programs that will focus on advancing building science practice and respond to future industry trends and emerging technologies. ☼

SOLPLAN REVIEW is an independent Canadian Journal published 6 times per year to serve the needs of professionals and interested lay persons. It provides news, technical details, new product information, insights and commentary on developments covering all aspects of building science and energy efficient building practice for new and retrofit residential construction. Technical information is presented in a clear, concise manner without resorting to jargon.

SOLPLAN REVIEW is an independent subscription supported publication that relies on the support of readers. If you are seeing this journal for the first time, and find it valuable, why not ensure that you don't miss any copies. Subscribe today!

YES, I WANT TO SUBSCRIBE TO SOLPLAN REVIEW

In Canada: 1 year: $56.00 ($50.00 + 6.00) [NB, NS, NL $56.50 includes HST] AB, SK, MB, PEI, Territories $52.50 ($50.00 + 2.50 GST)
2 years: $100.80 ($90.00 + 10.80) [NB, NS, NL $101.13 includes HST] AB, SK, MB, PEI, Territories $94.50 ($90.00 + 4.50 GST)
USA and other foreign: 1 year $57.00 per year, 2 years $103.50 (USA and other foreign in US funds).

Pay by: VISA ☐ MASTERCARD ☐ AMERICAN EXPRESS ☐ CHEQUE/CHECK ☐

Card No ______________________ Exp date

Signature ______________________

NAME ______________________

ADDRESS ______________________

POST CODE ______________________

the drawing-room graphis services ltd.
PO Box 86627 North Vancouver, BC V7L 4L2
Fax: 604-689-1841
e-mail: solplan@shaw.ca

GST registration: R105208805